AGX™-V Precision Universal Testing Machine

Application News

Shear Test of Composite Material Conforming to JIS K7079 Method B and Visualization of Strain Distribution

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User Benefits

- Enables shear testing of CFRP conforming to JIS K7079 Method B.
- Visualization of the strain distribution is possible by using Real-Time Strain View™.

■ Introduction

Carbon fiber reinforced plastic (CFRP) has high specific strength/specific stiffness in comparison with metals, and is used in transportation equipment to improve fuel economy by weight reduction. However, unlike conventional homogeneous materials, as a composite material, CFRP is anisotropic, and displays complex fracture behaviors involving tension, compression, bending, in-plane shear, out-of-plane shear, or those combinations, depending on the direction of the principal stress axis under load. In recent years, CAE analysis has been widely adopted in the industrial world because it can reduce the number of tests required, thereby reducing the cost of new product development. Since various property values are needed in order to enhance the accuracy of predictions of the performance of newly-designed products, there is strong demand for test methods that enable a pure evaluation of the respective fracture behaviors when conducting test evaluations of CFRP.

In this experiment, a shear test of CFRP was carried out in accordance with JIS K7079 Method B, which is called the "two pairs of rails method" (or two-rail shear method). In addition, the strain distribution during the test was visualized by using Real-Time Strain View.

■ Measurement System

The test was carried out using an Autograph AGX-V precision universal testing machine and a two-rail in-plane shear test jig. The two-rail method is a form of test in which two parallel sides of a rectangular plate (test material) are clamped between rigid materials (rails), and mutually different parallel forces are applied to the rails along each rigid material, creating a condition of shear stress in the test region. If the longitudinal ends of the test material are removed, the shear stress distribution is substantially uniform [1]. Fig. 1 shows a photograph of a test specimen. Biaxial strain gauges were glued to the front and back sides of the specimen, and tabs of glass fiber reinforced plastic having the same thickness as the specimen were attached to the reinforced portion of the specimen. Fig. 2 shows the condition of the test, and Table 1 shows the configuration of the test equipment.

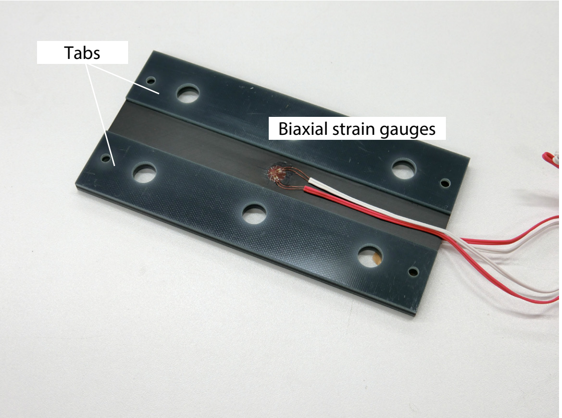

Fig. 1 Test Specimen

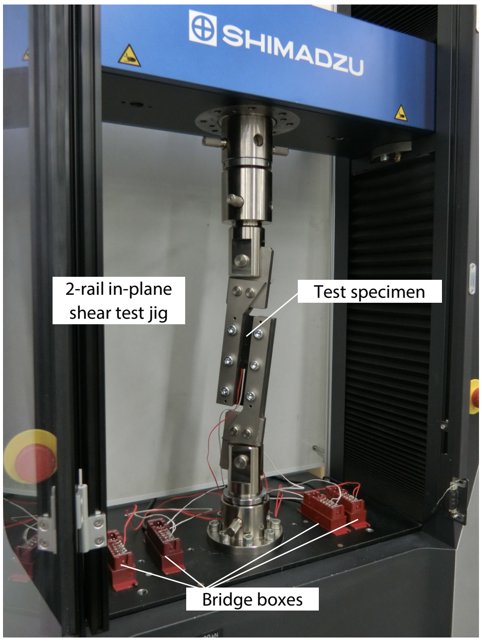

Fig. 2 Condition of Test

Table 1 Test Equipment

Precision universal testing machine	: AGX-V
Load cell	: 100 kN
Grips	: 2-rail in-plane shear test jig
Strain measurement	: Dynamic Strainmeter, bridge boxes, biaxial strain gauges
Strain distribution measurement	: Real-Time Strain View

■ Test Results

Table 2 shows the test conditions and specimen information. Fig. 3 shows the shear strain on the two sides of the specimen against test time. From Fig. 3, it can be understood that there is almost no difference between the front and back sides of the specimen as the test proceeds. Fig. 4 shows the shear stress-shear strain diagram, and Table 3 shows the test results.

Table 2 Test Conditions and Specimen Information

Test speed	: 1 mm/min
Specimen material	: CFRP quasi-isotropic laminate material
Laminate configuration	: [45/0/-45/90]s
Specimen dimensions	: Conforming to JIS K7079

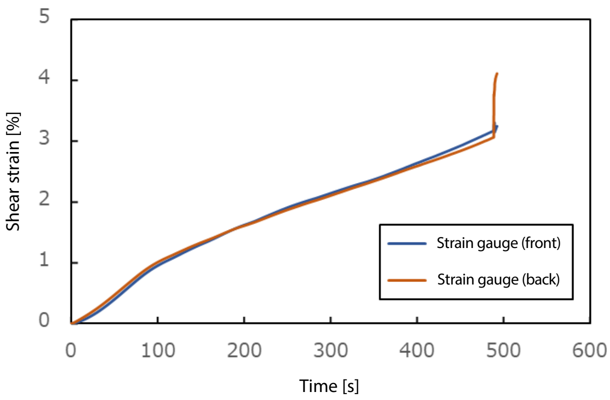

Fig. 3 Shear Strain-Test Time Diagram

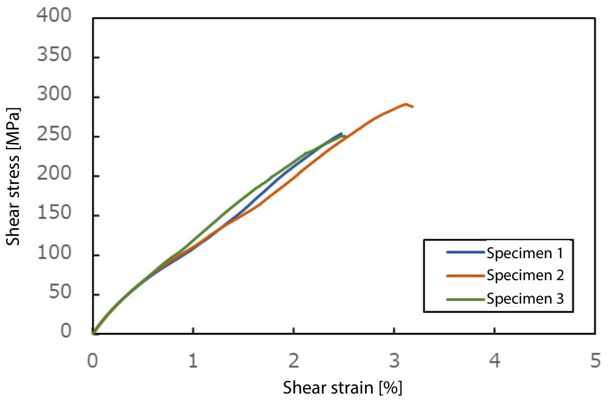

Fig. 4 Shear Stress-Shear Strain Diagram

Table 3 Test Results

In-plane shear strength	: 265.6 MPa
In-plane shear modulus	: 147.1 MPa

■ Visualization of Strain Distribution

The optional software Real-Time Strain View for use with the TRViewX non-contact digital video extensometer makes it possible to display the strained portion of test specimens in real-time. The video record can also be displayed synchronized to the test results (test force-displacement diagram) after the test.

Fig. 5 shows the condition of a test using Real-Time Strain View. A dedicated "grid mark" seal is attached to the front side of the specimen, as shown in Fig. 5.

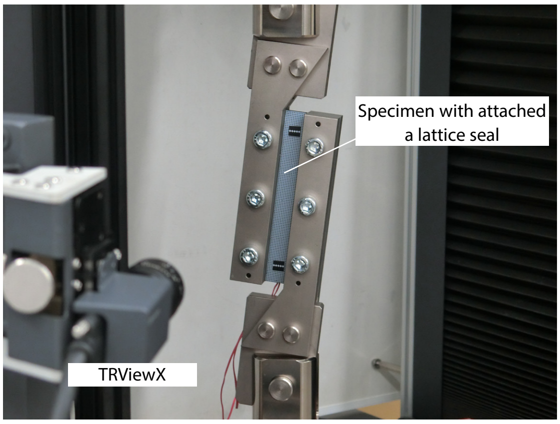

Fig. 5 Condition of Test Using Real-Time Strain View

Fig. 6 shows the distribution of shear strain recorded by Real-Time Strain View. Fig. 6 shows the strain distribution of specimen 3 in Fig. 4. In Fig. 6, image (1) shows the start of the test, and image (6) shows the specimen just before fracture. The shear strain just before fracture is about 2.5 %, which is substantially the same as in Fig. 4.

■ Conclusion

This article describes a shear test of CFRP carried out in accordance with JIS K7079 Method B. The strain distribution was also visualized by using Real-Time Strain View.

As demonstrated in this experiment, shear testing of CFRP conforming to JIS K7079 Method B is possible by using this system.

<References>

1) Yoshio Aoki, Journal of the Japan Society of Composite Materials, 24, 4 (1998).

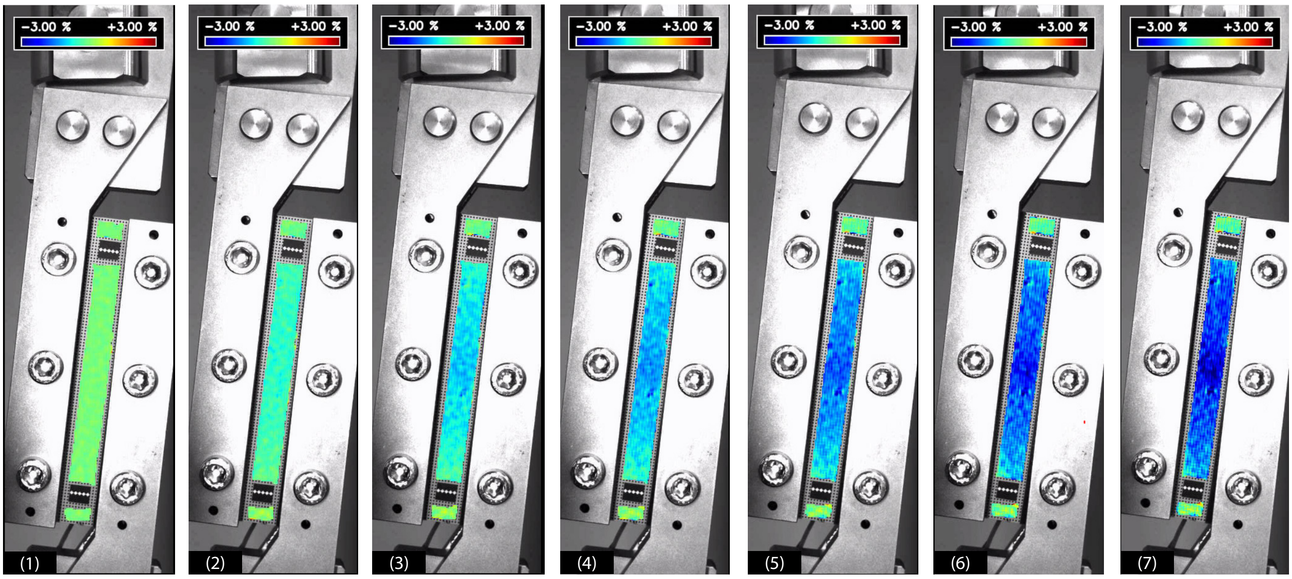

Fig. 6 Shear Strain Distribution by Real-Time Strain View
*The direction of shear strain is the opposite of the definition in the standard.

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